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OHIO BASIN REGION. SUMMARY STATEMENT. POSITION ON THERMAL POLLUTION WITHIN THE OHIO RIVER BASIN

FEDERAL WATER POLLUTION CONTROL ADMINISTRATION, CINCINNATI, OHIO

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OHIO BASIN REGION

SUMMARY STATEMENT

POSITION ON THERMAL POLLUTION WITHIN THE
OHIO RIVER BASIN

INTRODUCTION

The present aquatic life population and temperature conditions in the Ohio Basin should first be described before temperatures can be recommended as part of the criteria for aquatic life. It is also important to describe the Ohio River's capability to dissipate heat. This characteristic is important and seldom really considered. Much of the description would fit tributaries and perhaps help explain existing conditions in certain ones. The relationship of river temperature to needed degree of treatment in order to meet dissolved oxygen requirements is also a factor to be considered.

In order to describe existing aquatic life conditions, some "yardstick" must be used. Dr. Mount has developed a family of curves to represent annual temperature regimes and to identify desirable species able to thrive under each of these temperature regimes. Each curve will show the length of time that the temperatures are near or at the maximum during the summer months, and will indicate the amount of cooling required to initiate reproduction during the winter period. The results are reduced to five tables; Class I, Class II, and Class III for warm water biota, and Class A and Class B for cold-water biota.

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The aquatic life population and temperature conditions in the Ohio Basin are described in order to recommend temperatures as part of the criteria for aquatic life. The relationship of river temperature to needed degree of treatment in order to meet dissolved oxygen requirements is also considered. A family of curves was developed to represent annual temperature regimes and to identify desireable species able to thrive under each of these temperature regimes. Each curve shows the length of time that the temperatures are near or at the maximum during the summer months, and indicates the amount of cooling required to initiate reproduction during the winter period.

17. Key Words and Document Analysis. 17a. Descriptors

17b. Identifiers/Open-Ended Terms

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The development of these tables should correct the very pronounced tendency of non-biologists to consider "aquatic life" as one group and having one specific temperature requirement throughout the entire United States. This tendency has led to the conclusion that if that one temperature can be determined, all problems can be solved for all aquatic life. Dr. Mount's tables describe temperature limits needed for the several periods to protect certain species of fish.

Dr. Mount has repeatedly pointed out the obvious fact that above-normal temperatures may be quite beneficial to the organisms, and that the addition of heat may be highly desirable rather than totally adverse. One of the purposes of developing curves and tables for the several intervals of desirable temperature is to show when heat addition is desirable and when it is a damaging pollutant.

Class I lists eleven species of fish which occur in the Ohio River and its tributaries. Class II lists ten species from Class I and eliminates the sauger. There are an estimated 1.5 million sauger, weighing 350,000 pounds, in the Main Stem Ohio. Additional sauger exist in some of the tributaries. Class III lists six species from Class I, and eliminates five species, i.e. the sauger, smallmouth bass, emerald shiner, golden redhorse, and white sucker. Class A is for cold-water biota (trout) with conditions to reproduce. Class B lists identical species without reproduction; these would be called put and take trout streams. These five tables, then, are the yard-sticks to describe existing aquatic life conditions and temperature and recommended aquatic life and temperature.

DERIVATION OF AQUATIC LIFE REQUIREMENTS FOR THE TEMPERATURE CHARACTERISTIC

Donald I. Mount, Ph.D.

AQUATIC LIFE TEMPERATURE CRITERIA

CLASS I -- WARM WATER BIOTA

SPECIES -- Largemouth Bass
Smallmouth Bass
White Bass
Sauger
Channel Catfish
Emerald Shiner
Freshwater Drum
Golden Redhorse
Buffalo
White Sucker
Fathead Minnow

	Period Mean, °F.	Hourly Max., °F.
December-February	48	55
March 1-15	50	56
March 16-31	52	58
April 1-15	55	60
April 16-30	58	62
May 1-15	62	64
May 16-31	68	72
June 1-15	75	79
June 16-30	78	82
July-September	82	86
October	75	82
November	65	72

AQUATIC LIFE TEMPERATURE CRITERIA

CLASS II -- WARM WATER BIOTA

SPECIES -- Largemouth Bass
Smallmouth Bass
White Bass
Channel Catfish
Emerald Shiner
Freshwater Drum
Golden Redhorse
Buffalo
White Sucker
Fathead Minnow

	Period Mean, °F.	Hourly Max., °F.
December	55	60
January	48	55
February	48	55
March 1-15	52	58
March 16-31	58	64
April 1-15	64	70
April 16-30	68	72
May 1-15	70	74
May 16-31	74	78
June 1-15	78	82
June 16-30	82	85
July	84	86
August	84	86
September	84	86
October	75	82
November	65	72

AQUATIC LIFE TEMPERATURE CRITERIA

CLASS III -- WARM WATER BIOTA

SPECIES -- Largemouth Bass
White Bass
Channel Catfish
Freshwater Drum
Buffalo
Fathead Minnow

	Period Mean, ^{o}F.	Hourly Max., ^{o}F.	96-Hr.TL_m, ^{o}F.*
December	55	60	60
January	50	55	55
February	50	55	55
March 1-15	55	60	60
March 16-31	60	65	65
April 1-15	65	70	77
April 16-30	70	75	80
May 1-15	70	75	83
May 16-31	75	80	86
June 1-15	78	82	86
June 16-30	82	86	92
July	86	90	92
August	86	90	90
September	86	90	90
October	75	82	82
November	65	72	72

*96-Hr. TL_m, ^{o}F. -- denotes maximum temperatures that should be allowed in mixing zone so 50 per cent of the specified fish population would survive in a 96-hour period.

AQUATIC LIFE TEMPERATURE CRITERIA

CLASS A -- COLD WATER BIOTA

SPECIES -- BROOK, BROWN & RAINBOW TROUT

(WITH REPRODUCTION)

	Period Mean, ^{o}F.	Hourly Max., ^{o}F.	96-Hr.TL_m, ^{o}F.*
December	50	55	64
January	50	55	64
February	50	55	64
March 1-15	50	55	64
March 16-31	50	55	64
April 1-15	50	55	66
April 16-30	50	55	66
May 1-15	54	58	70
May 16-31	58	62	70
June 1-15	62	66	75
June 16-30	67	70	77
July	67	70	77
August	67	70	77
September	58	62	77
October	50	55	64
November	50	55	64

*96-Hr. TL_m, ^{o}F. -- denotes maximum temperatures that should be allowed in mixing zone so 50 per cent of the specified fish population would survive in a 96-hour period.

AQUATIC LIFE TEMPERATURE CRITERIA

CLASS B -- COLD WATER BIOTA

(PUT AND TAKE TROUT STREAMS)

SPECIES -- BROOK, BROWN & RAINBOW TROUT

(WITHOUT REPRODUCTION)

	Period Mean, °F.	Hourly Max., °F.	96-Hr. TL_m, °F.*
December	55	60	64
January	50	55	64
February	50	55	64
March 1-15	55	60	64
March 16-31	55	60	64
April 1-15	60	65	66
April 16-30	60	65	66
May 1-15	60	65	70
May 16-31	66	70	70
June	66	70	75
July	66	70	77
August	66	70	77
September	66	70	77
October	60	65	70
November	55	60	64

*96-Hr. TL_m, °F. -- denotes maximum temperatures that should be allowed in mixing zone so 50 per cent of the specified fish population would survive in a 96-hour period.

EXISTING CONDITIONS

The map "Present Stream Conditions for Temperature and Biota Classifications" shows the inter-state streams in the Ohio Basin. The existing classification has been determined by temperature records and actual collections of fish by qualified biologists.

The water temperatures for the years 1963-1968 at Cincinnati meet the Class I objectives during September through March. During the period April through August, there were only a few minor failures to meet the objective in 7 of the 8 specified time intervals. During the April through August period, temperature conditions are marginal for Class I species. However, upstream from Cincinnati and the Cincinnati G&E Company Beckjord thermal power plant, the Sauger was found in greatest abundance at the Meldahl and Greenup Locks. These data show that the Class I conditions could be met at least 95 percent of the time, at Cincinnati, below the Beckjord Plant.

At Huntington, the period means and hourly maximums for the six monthly and 2 fifteen day time intervals from September through March were within the recommended Class I criteria. During April through August the recommended Class II criteria for maximum hourly values were met 95 percent of the time. There were only 3 failures to meet Class II recommended period mean during the six years of record. These failures were only by $0.1^{\circ}F$, $0.4^{\circ}F$, and $2.1^{\circ}F$.

CONSIDERATIONS

1. Analysis shows that the Ohio River, Markland Pool has a poor ability to dissipate heat to the atmosphere. During the summer seasons, the Ohio Valley is characterized by high humidity (65 - 71 percent), slow winds (5 - 6-1/2 mph), high air temperatures, and intense solar radiation. Analysis further shows that under natural summer conditions, the equilibrium water temperature is from four to eleven degrees warmer than air temperature. During the summer season, the Markland Pool tends to hold heat like a sponge holds water. It has been computed that with a flow of 10,000 cfs it would take 200 miles of river length similar to Markland Pool, in order to dissipate 99 percent of the heat added from the Beckjord Plant. The river is a poor cooling facility, due to weather characteristics of the Ohio Valley. Much of what has been said with regard to weather characteristics and poor capability to dissipate heat loads applies to tributaries to the Ohio River also.

2. The tendency towards increased stream temperatures will increase problems associated with oxygen and biochemical oxygen demand by increasing the rate of deoxygenation thereby decreasing the time period for the maximum sag to occur, and decreases the available oxygen concentration. If the dissolved oxygen objective, the flow, and the waste loads are held constant, and if increased temperature is permitted, the other municipal and industrial waste treatment plants must be designed to operate at a greater efficiency to achieve the dissolved oxygen objective. The manipulation of stream temperatures is thereby related to other water quality objectives beyond the interest of the thermal power plant owners, and often in

partial conflict with the operation of both municipal and other industrial waste treatment plants required to reduce biochemical oxygen demand loads to meet a dissolved oxygen standard.

An increase in river water temperature means that an increase in organic removal would be required. How much depends on the situation. For example, at Indianapolis with a dissolved oxygen requirement of 5 mg/l, and the flow and waste load are held constant, an increase of four degrees centigrade in the river from 16°C to 20°C, would require an increase in treatment plant efficiency from 90 percent to 94 percent. A temperature increase from 20° to 26° C would require an increase in treatment from 94 percent to 98 percent. The first example means a reduction of 40 percent of the remaining load, and the second example means reduction of 67 percent of the remaining load.

The net result is that the public will pay more for municipal treatment requirements with the existence of excess temperature loads to rivers.

3. Cooling towers increase the operational costs by about 0.2 to 0.4 mills/KWH over the life of a projected facility. It is concluded that the cost of providing thermal pollution control is not a restrictive factor in the production of electricity and the impact of thermal pollution control on the consumer cost of electricity is minimal.

4. An estimate of potential loss of aquatic life due to thermal pollution and cost of treatment is discussed below.

The public is going to pay the cost of pollution abatement either by increased municipal costs or by increased product costs, or both. The question arises as to which is the least costly combination to the public.

The tendency towards increased river temperatures will require that some communities and organic waste producing industries will have to increase the efficiency of treatment plants to meet dissolved oxygen standards. As you get into the higher ranges of removal of wastes, the cost rapidly approaches that of advanced waste treatment. The cost of cooling is relatively cheap.

If thermal pollution is not abated, there will be at least the same cost to the public and in addition, there will be a tremendous aquatic life loss. For example, to lower the Ohio River, Main Stem from Class I to Class II would mean the eventual loss of about 1.5 million Sauger weighing 350, 000 pounds. Conversely to upgrade the entire length, 981 miles and 207,000 surface acres, would allow a potential fishery of four million Sauger with a weight of 1.5 million pounds.

To downgrade the Ohio River further, from Class II to Class III, would mean an additional loss of the valuable forage fish, the emerald shiner. The emerald shiner is an essential part of the food chain of the higher fish life. This would amount to 100 million emerald shiners weighing 400,000 pounds.

It would appear that the best bargain for the public would be abatement of thermal pollution loads as required to meet Class I temperatures on the Main Stem, Ohio.

RECOMMENDATION

The Map "The Proposed Stream Criteria for Temperature and Biota Classification" shows the recommended classification of the interstate streams in the Ohio Basin.

The entire Main Stem, Ohio is recommended to be Class I. In the Upper Ohio, this recommendation is consistent with the approved water quality standards of Pennsylvania and West Virginia. From Cincinnati upstream at least to Greenup Lock (nearly to the West Virginia-Kentucky boundary) this recommendation is consistent with existing temperature data and the biota actually found in Mehldahl and Greenup Locks, and the non-degradation statements of Kentucky, Ohio, and ORSANCO.

The biota in the river reach downstream from Cincinnati to downstream from Louisville was found to be indicative of Class II. The biota and the temperatures in the Ohio River downstream from this reach are representative of Class I. Efforts by the power industries must equal efforts by other Ohio River industries to enhance water quality. From Cincinnati downstream to Cairo, Illinois, Class I would then be consistent with the non-degradation statements of Kentucky, Illinois, and ORSANCO.

The aquatic life temperature criteria for Class III warm water biota for Ohio River tributaries could be modified to specify a maximum hourly value of 93°F. during July, August, and September only where natural conditions cause such temperatures to develop. Should ORSANCO choose to deviate from the proposed Class III recommendation, a modified Class III could be considered with the hourly maximum temperatures not to exceed 93°F. during July, August, or September of any year. Regulatory agencies should take cognizance of unusual natural temperature-induced conditions.

The capability of the Ohio Basin streams to dissipate heat is poor. The classifications in many cases are marginal. Therefore, a policy of requiring on-shore cooling facilities for thermal power industries should be adopted by ORSANCO.